Land Evaluation for agricultural purposes - Bulgarian system
PART I. General principles

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1. Abstract

The Bulgarian system of land evaluation for agricultural purposes started to develop theoretically in the 1960`s, since when it has been updated several times. The finally accepted variant is from 1988. The system is in itself a parametrical method, which evaluates the characteristics of agricultural land through original methods, developed in Bulgaria, This is done according to the requirements of 22 basic crops for agriculture with and without irrigation. The aim of the present project is to show systematically the main principles of land evaluation as applied in Bulgaria. This is an information paper aiming at popularization abroad. After numerous meetings of the authors of this work with colleagues mainly from Western Europe, they have been convinced that in the world our system of evaluation is not well known. We consider it as having values which must be shared with scientists from countries which wish to develop similar scientific and applied science activities.

2. Introduction

The Bulgarian system of agricultural land evaluation began to develop in the 1960`s (Trashliev, 1962). In 1970 Petrov and his team published "Methods for introduction of cadastre of agricultural land in Bulgaria", which was updated several times afterwards. The last officially adopted variant of this practical system for land evaluation was from Petrov (1988).

The system is in itself a parametrical method, whish evaluates the characteristics of agricultural land (climatic, relief, soil, etc.) through original methods developed in Bulgaria. This is done in compliance with the requirements of 22 basic crops for condition of irrigation and non-irrigation agriculture. The social and economical changes in the country during the last 10 years led to re-evaluation of all land from the agricultural fund on a large scal;e and that was in fact good practical test through which the advantages of Bulgarian land evaluation system became clear. (Banov & Georgiev, 1998; Georgiev B.' 1994a, 1994b, 1994c, 1998, 1999a, 1999b).

The aim of the present project is to show the main principles of land evaluation applied in Bulgaria. This is an information paper, which does not involve scientific novelties of Bulgarian science but aims at popularization of Bulgarian system abroad. After numerous meetings of the authors of this paper with colleagues abroad they were convinced that Bulgarian land evaluation is not very popular abroad. We consider it as having values that must be shared and may be useful in countries that wish to develop similar science and applied science activities.

3. Methods

Crop requirement: we have taken into consideration the requirements to climate, relief and soils of 22 basic crops: wheat, maize' rice, soya, sunflower, sugar beet, oriental tobacco, wide-leaf tobacco, cotton, flax, tomatoes, peppers, potatoes, alfalfa, pastures and meadows, apples, pears, plums, peaches, cherries, raspberries, and vines. A differentiation is also made on the basis of requirements of various varieties and hybrids.

Climate characteristics: data bases of multi-annual observation for a period not shorter than 35 years on the whole territory of the country. Rain characteristics are mainly taken into consideration as balance of humidity (with and without winter supplies of humidity in soil) for various period of time (whole vegetation period, important phases from the plant development, etc.). The balances are usually calculated through basic equation 1:

$$B = W_S + P_I - E_I + P_{II} - E_{II} + P_{III} - E_{III} + \ldots. \quad (1)$$

where:

B	- humidity balance (mm);
W_S	- initial supply of humidity in soil (mm);
P_I, P_{II}, P_{III} ...	- rainfall amount for every month (mm);
E_I, E_{II}, E_{II} …	- evaporability (Ivanov, 1941) for every month.

Under conditions in Bulgaria it has been proved that Ivanov's equation shows results of evaporability very close to the practical ones observed with crops:

$$E = 0.0018 (25 + t)^2 (100 - a) \quad (2)$$

where:

E	- monthly evaporability (mm);
t	- average monthly air temperature (^{0}C);
a	- relative air humidity (%).

As in Bulgaria the most characteristic balance of atmospheric evaporability is generally deficit, in practice most often the distribution of rain is more important than its amount.

As far as temperature characteristics are concerned we most often calculate the amounts of effective air temperatures higher than 10^0 C (considered as a biological boundary for optimal development of most agricultural crops, but not of all). These calculations lead to established understanding in Bulgaria for the lengths of possible growing periods, favorable duration of crop stages, etc. Equation 3 shows the principal way of making such calculation.

$$\Sigma_{T\,^0C>10^0} = (t_1 + t_2 + t_3 + \ldots + t_n) - 10\,n \quad (3)$$

where:

$\Sigma_{T\,^0C>10^0}$	- sum of effective temperatures (for the period of average 24-hour temperature >10 ^{0}C);
t_1, t_2, t_3, … t_n	- subsequent observation of average 24-hour air temperatures in ^{0}C;
1, 2, … n	- number of days in the period under research.

Naturally the rich meteorological archive in Bulgaria has data for 2 more biological boundaries -5 ^{0}C and 15 ^{0}C, which must be worked with in an analogous way.

As temperature characteristics we also use data of extremely high or low values correspondingly in winter and summer, and the dates of last spring and first winter frosts, etc. Algorithms have been developed for obtaining climatic coefficients for each agricultural crop under observation. For practical convenience the territory of the country has been mapped.

Relief: the relief characteristics of Bulgarian system of land evaluation are taken in an indirect account, mostly with repair of temperature conditions and rainfall amount. As in Bulgaria we take into account an economic super-structure of the commented system of evaluation, the influence of slopes on agricultural technologies is considered at a later stage, which is not an aim of the current paper.

Table 1 Soil characteristics in Bulgarian System for Land Evaluation

Characteristics	Measure
1. Texture (particles size class < 0.01 mm – Katchinsky scale)	
plow layer	%
Sub-plow layers	%
2. Thickness of humus horizon	cm
3. Thickness of soil profile (bedrock depth)	cm
4. Clay content ratio (B/A horizons, Katchinsky scale)	coefficient
5. Soil reaction (pH in H_2O)	pH
6. Humus content (after Turin)	%
7. Ground water table	cm
8. Erosion or accumulation status (Bulgarian classification scale)	degree
9. Salinity and/or alkalinity (water soluble salts/exchangeable Na)	%
10. Stoniness	%
11. Flooding	cm

Soil characteristics: as a rule information on soil characteristics is derived from data bases of large-scale soil research (M 1: 10000) which cover almost all territory of the country. In few cases when those are not available we use the data from M 1: 25000 or data from specific research

Algorithms and scales for evaluation of every characteristic under observation are prepared in advance according to the requirements of individual crops. Some of the scales envisage using an evaluation in relative numbers ranging from 0 to 1000, while others are based on certain coefficients.

The soil characteristics that are worked with are shown in Table 1

4. Results

General principles for Land evaluation: using scales made in advance with numbers from 1 to 7 inclusive (Table 1) we define directly worth evaluation (Rxx). The average arithmetical figure if them represents the so called Soil Rating (SR), which provides number characteristics of the suitability of the soil substrate (equation 4). If one of the characteristics has evaluation result 0, it is considered that the general result is also 0, the rest of the evaluation numbers are not applied and this is taken for Non-suitable land – category 10" (Table 2). The scale for evaluation of SP is closed between 0.00 and 100.00 evaluation units.

For the remaining soil-characteristics (numbers 8, 9, 10 and 11 from Table 1), for the climatic conditions and those of irrigation according to pre-defined algorithms and scales we define the so called "correction coefficients". Through subsequent multiplication of the coefficients and the Soil Rating we obtain the so called Field Rating, which leads to maximum precise account of terrain conditions. The ultimate equation is given in Formula 5.

Normally the worth of the correction coefficient are between 0.00 and 1.00, but there are a few exceptions (higher than 1.00) with evaluation of the characteristics "erosion and accumulation" for some crops and all coefficients of irrigation providing there is such irrigation, For that reason the evaluation scale sometimes is open – it can accept values of above 100.00 units.

$$SR = \frac{R_{TX} + R_{THH} + R_{TSP} + R_{CCR} + R_{pH} + R_{HC} + R_{GWT}}{n^R} \quad (4)$$

$$FR = \frac{R_{TX} + R_{THH} + R_{TSP} + R_{CCR} + R_{pH} + R_{HC} + R_{GWT}}{n^R} k_{EA}\, k_{SA}\, k_{ST}\, k_{FL}\, k_{CL}\, k_{IR} \quad (5)$$

where:

SR	Soil Rating	FR	Field Rating
R_{TX}	Texture Rating	k_{EA}	Erosion or accumulation coefficient
R_{THH}	Thickness of humus horizon Rating	k_{SA}	Salinity/alkalinity coefficient
R_{TSP}	Thickness of soil profile Rating	k_{ST}	Stoniness coefficient
R_{CCR}	Clay content ratio Rating	k_{FL}	Flooding coefficient
R_{pH}	Soil reaction Rating	k_{CL}	Climate coefficient
R_{HC}	Humus content Rating	k_{IR}	Irrigation coefficient
R_{GWT}	Ground water table Rating		
n^R	Number of Ratings		

Table 2 Final classification of land suitability for different land use

Groups	Categories	Field Ratings
1. Very suitable lands	1	> 90
	2	80 ÷ 90
2. Suitable lands	3	70 ÷ 80
	4	60 ÷ 70
3. Moderately suitable lands	5	50 ÷ 60
	6	40 ÷ 50
4. Lands with severe limitations	7	30 ÷ 40
	8	20 ÷ 30
5. Non-suitable lands	9	10 ÷ 20
	10	< 10

Final classification of land suitability: the final classification of evaluated land in Bulgaria is shown in Table 2. According to established suitability land is classified on high level in 5 groups and on lower level in 10 categories.

This is valid individually for each of the crops under observation, but we also envisage calculation of the so called Average Agronomic Rate, which provides certain summarized idea in some regions of intensive agriculture which are characterized by multi-type land usage.

From the above brief review of the main principles of the adopted in Bulgaria system of land evaluation it becomes clear that it is mainly characterized by the following features:

1. It makes good use of the world scientific experience – it uses parametrical methods for evaluation the basic characteristics of land.
2. It has unique approach, adapted to the regional characteristics of crops, the existing data base and the directives in land usage.

The stated above proves that the Bulgarian system is attractive and can be adapted and applied in case of necessity in other countries.

5. References

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